

## CLAIMS

What is claimed is:

1. A monolithically integrated optical network device (20), comprising: a bipolar transistor (10) realized in a silicon substrate (11) that can be biased into an avalanche condition to emit photons; and a photonic bandgap (PBG) structure (22) monolithically integrated with the bipolar transistor (10) to act as an optical wave guide (16) for the photons emitted by the bipolar transistor (10).
2. The monolithically integrated optical network device (20) of claim 1, wherein the bipolar transistor (10) includes a surface covered in a reflective material (25) that blocks emission of photons through the surface.
3. The monolithically integrated optical network device (20) of claim 2, wherein the surface includes an optical window (24) that allows photons to pass from the bipolar transistor to the surrounding silicon substrate (11).
4. The monolithically integrated optical network device (20) of claim 2, wherein the reflective material comprises a  $\frac{1}{2} \lambda$ -layer.
5. The monolithically integrated optical network device (20) of claim 3, wherein the PBG structure (22) includes a plurality of porous columns (14) realized in the silicon substrate (11) adjacent to the optical window (24) defined on the surface of the bipolar transistor (10).
6. The monolithically integrated optical network device (20) of claim 5, wherein the plurality of porous columns are arranged to define a channel (16) that provides the wave guide for the photons emitted through the optical window.
7. The monolithically integrated optical network device (20) of claim 1, wherein the emission of light from the bipolar transistor is regulated by a control system (29).
8. The monolithically integrated optical network device (20) of claim 1, wherein the bipolar transistor (10) is fabricated from a material selected from the group consisting of: SiGe, SiGeC, InP, and GaAs.
9. The monolithically integrated optical network device (20) of claim 1, wherein the silicon substrate is fabricated from a material selected from the group consisting of: CMOS, SiGe, SiGeC, and BiCMOS.
10. A monolithically integrated optical network (13), comprising: a bipolar transistor (10) realized in a silicon substrate (11) that can be biased into an avalanche

condition to emit photon pulses; a photonic bandgap (PBG) structure (22) monolithically integrated with the bipolar transistor (10) in the silicon substrate (11) that acts as an optical wave guide (16) for the photon pulses generated by the bipolar transistor (10); and a receiving device (27a-d) realized proximate a distal end of the optical wave (16) guide for receiving the photon pulses generated by the bipolar transistor (10).

11. The monolithically integrated optical network of claim 10, further comprising a control system (29) for regulating the emission of photon pulses from the bipolar transistor.

12. The monolithically integrated optical network of claim 10, wherein the receiving device comprises a photo diode.

13. The monolithically integrated optical network of claim 10, wherein the bipolar transistor (10) includes a surface covered in a reflective material (25) that blocks emission of photons pulses through the surface.

14. The monolithically integrated optical network of claim 13, wherein the surface includes an optical window (24) that allows photon pulses to pass from the bipolar transistor to the surrounding silicon substrate.

15. The monolithically integrated optical network of claim 14, wherein the PBG structure (22) includes a plurality of porous columns (14) realized in the silicon substrate adjacent to the optical window defined on the surface of the bipolar transistor.

16. The monolithically integrated optical network of claim 15, wherein the plurality of porous columns are arranged to define a channel that provides the wave guide for the photons emitted through the optical window.

17. The monolithically integrated optical network of claim 13, wherein the reflective material (25) comprises a  $\frac{1}{2} \lambda$ -layer.

18. The monolithically integrated optical network of claim 10, wherein the bipolar transistor (10) is fabricated from a material selected from the group consisting of: SiGe, SiGeC, InP, and GaAs.

19. The monolithically integrated optical network of claim 10, wherein the silicon substrate (11) is fabricated from a material selected from the group consisting of: CMOS, SiGe, SiGeC, and BiCMOS.